



## Doppler Ultrasound Study of Umbilical Artery and Middle Cerebral Artery in Clinically Suspected IUGR Pregnancies

### KEYWORDS

Intrauterine growth retardation; Umbilical artery Doppler, Middle cerebral artery Doppler; Fetal Doppler; Cerebro-placental Ratio

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**ABSTRACT** *Background :* Doppler indices as predictors of adverse perinatal outcome in clinically suspected IUGR pregnancies and to establish the role of Doppler ultrasound in the management of IUGR pregnancy. So the aim of the study to evaluate the usefulness of middle cerebral artery and umbilical artery in clinically suspected IUGR pregnancies. *Materials & Methods:* We studied Doppler Velocimetry of umbilical artery and Middle cerebral artery in 50 cases with clinical suspicion of IUGR between 31 to 40 weeks of gestation. Pulsatility Index was used as the Doppler index. Findings of Doppler studies were correlated with the adverse perinatal outcomes like perinatal deaths, emergency CS for foetal distress, low Apgar score, (5 min Apgar<7), and admission to NICU for complications of low birth weight. *Results:* Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (sensitivity 95.8%) to predict adverse outcome. It was more sensitive than either UA PI (sensitivity 91%) or MCA PI (sensitivity 87.5%). Diagnostic accuracy of Cerebroplacental ratio (Accuracy=90%) was better than UAPI (Accuracy=88%) and MCAPI (Accuracy=66%) in predicting adverse outcomes. *Conclusion:* Fetal Doppler indices, in particular ratios that include measurements obtained from the cerebral circulation, help in the recognition of the compromised growth-retarded fetus.

### Introduction :

Intrauterine growth restriction (IUGR) is associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment<sup>1,2,3</sup>. Ultrasonographic (US) biometry helps to identify a heterogeneous group of small-for-gestational age fetuses that include fetuses with IUGR, fetuses with small constitution, and fetuses with appropriate growth (misdiagnosed as small). The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care. Umbilical arterial (UA) Doppler velocimetry is the most rigorously evaluated test among noninvasive tests of fetal well-being<sup>4</sup>. A meta-analysis of randomized controlled trials of UA Doppler velocimetry in high-risk pregnancies (mainly pregnancies with associated hypertension and suspected IUGR) demonstrated that its use was associated with a trend toward reduction of perinatal mortality, although there was no effect on neonatal morbidity<sup>4</sup>. Animal studies have documented redistribution of cardiac output in response to hypoxemia, with increased flow to the brain and decreased flow to other organs<sup>5</sup>. Doppler US studies of the human fetal circulation have shown that in fetuses with IUGR there is a significant reduction of middle cerebral arterial (MCA) pulsatility index when compared with those in normal fetuses<sup>6,7</sup>. At cordocentesis, a significant correlation has been observed between hypoxemia in fetuses with IUGR and an abnormal MCA pulsatility index<sup>8,9</sup>. Results of several studies suggest that the MCAPI/UAPI Doppler ratio is more accurate in the prediction of adverse perinatal outcome than UA Doppler US alone<sup>10,11,12</sup>. Differences in study design, including the criteria for patient selection, the definition of adverse outcomes, different cutoff levels between normal and abnormal test results, and the small number of patients studied, make direct comparison of the studies difficult.

Our study was an effort at establishing the role of UA and MCA Doppler ultrasound in predicting adverse perinatal out-

come in clinically suspected IUGR pregnancies, and to determine the role of Doppler velocimetry in clinical management of such pregnancies.

### Methodology:

This study was approved by the Ethical Committee of our institution. The study was conducted for a period of two years from September 2011 to September 2013. Data for the study was collected from patients attending the department of Radio diagnosis. Singleton pregnancy Fetal gestational age of 31 to 40 weeks with clinically suspected intrauterine growth retardation (Estimated fetal weight <10th percentile for gestation) women were referred for antenatal Doppler. The gestational age was based on ultrasound biometry performed before the 20th gestational week, when the LMP is uncertain or not known and early ultrasound before 13 weeks has not been performed. Documented major congenital abnormality, Multiple gestations, Intrauterine death at the time of first Doppler examination were excluded from the study.

The study was conducted for a period of 2 years. Present study included a total number of 50 cases meeting the inclusion criteria. Doppler US evaluation was performed following a detailed clinical history, US biometry, and assessment of amniotic fluid and placental maturity. Follow up Doppler studies were performed if clinically indicated to determine a favourable or a worsening trend in the Doppler indices. However only the results of the first Doppler ultrasound were used for analysis of perinatal outcome.

We used GE LOGIQ 5 PRO with the transducer frequency of 3.5 –5.0 MHz. The Doppler wall filter was set at 50 –100 Hz. The patients were allowed to rest for 10 to 15mins in a semi-recumbent position prior to commencing the ultrasound investigation. Fetal biometry was performed initially.

The waveforms were obtained during fetal inactivity and apnoea. Umbilical artery Doppler flow velocity waveforms were obtained from a free loop of cord, and measurements taken when a clear waveform was acquired in the absence of fetal breathing or body movement.

The Pulsatility index (PI) was measured, and the presence or absence of end-diastolic frequencies was noted. The PI was used as it continues to reflect changes in resistance with progressive absence of end-diastolic frequencies or reverse flow, and the values are normally distributed in the third trimester.

For MCA Doppler US, a transverse image of the fetal head was obtained at the level of the sphenoid bones. Color flow imaging was used to display the circle of Willis. The MCA in the near field was insonated about 1 cm distal to its origin from the internal carotid artery.

Doppler US results were analyzed for prediction of perinatal outcome. Outcome variables included, Birth Weight, perinatal death, Emergency CS for fetal distress, Low Apgar score (5 min Apgar score less than 7), admission to NICU for complications of Low Birth Weight. Pregnancy was considered to have "Adverse outcome" when any of the complications like perinatal death, Emergency CS for fetal distress, 5 minute Apgar score of less than 7, Admission to NICU for complications of low birth weight. Pregnancy outcome was considered to be Uneventful or Favourable when the above complications were absent.

The outcome for each pregnancy was obtained by examining the labour ward records and neonatal intensive care unit records wherever appropriate. The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age<sup>13</sup>.

The MCA pulsatility index was considered abnormal if the value was below the 5th percentile of previously published values for gestational age<sup>13</sup>. The MCA/UA PI ratio (cerebro-placental ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut off value after 30th week because cerebral-umbilical Doppler ratio does not vary significantly between 30th and 40th weeks as reported by Wladimiroff et al<sup>14</sup> who observed a significant differences in cerebroplacental ratio only between weeks 26-38. After 26th week, the statistical comparison showed no significant differences between the intervals considered.

Arbeille et al<sup>15</sup> also found the cerebral-placental ratio constant during the pregnancy and suggested 1 as the cut off value; all values below 1 were considered abnormal. Gramellini et al<sup>11</sup> also used a single cut off value of 1.08. Therefore, in our study a single cutoff value (1.08) was used, above which velocimetry was considered normal and below which it was considered abnormal. The sensitivity, specificity, positive predictive value, negative predictive Value and diagnostic accuracy were determined for all Doppler measurements.

### Observations & Results

50 pregnancies studied for which acceptable wave forms were obtained from all the 50 cases. 7 cases were followed up with repeat Doppler.

56 % (n=28) of the mothers had Pregnancy Induced Hypertension, 22 % (n=11) had anemia, one patient had

diagnosed HELLP Syndrome (Hemolysis, Elevated Liver Enzymes and Low Platelet count) at first Doppler examination. 22% (n=11) had normal liquor and 78% (n=39) had Oligohydramnios at first Doppler examination.

76% of cases (n=38) had Grade III Placental maturity at the time of first Doppler Examination and 24 % (n=12) had Grade II Placental maturity.

Mean gestational age at the first Doppler US examination was 35.2 weeks+/- 3.46 weeks (2SD). 48% (n=24) fetuses had at least one abnormal outcome, of those; some (n=8) had more than one abnormal outcome. Remaining 26 fetuses had normal outcome.

Mean birth weight at delivery was 2.43kg +/- 0.26 kg (2SD). 60% of neonates (n=30) had birth weight of less than 2.5 kg. There were 7 intra uterine deaths and 43 live births. Of the 43 live births 8 Neonates were admitted to NICU. 7 neonates had 5 min Apgar score of less than 7 and 12 babies were born by emergency caesarian section.

Of the 7 IUDs 4 cases had reversal of diastolic flow and 3 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the fetus occurred within one week of diagnosis. And all the 4 cases were less than 32 weeks.

Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (sensitivity 95.8%). It was more sensitive than either UA PI (sensitivity 91%) or MCA PI (sensitivity 87.5%) alone in predicting any adverse outcome. Cerebroplacental Ratio and UA PI were equally specific (Specificity=84.6%) and MCA PI had comparably low specificity (specificity=46%). Cerebroplacental Ratio had highest Positive Predictive Value (PPV=85%) followed by UAPI (PPV=84%) and MCA PI (PPV=60%). Negative Predictive Value of Cerebroplacental Ratio was 95% when compared to 91% for UA PI and 80% for MCA. Diagnostic accuracy of Cerebroplacental ratio (Accuracy=90%) was better than UA PI. (Accuracy=88%) and MCA PI (Accuracy=66%) in predicting adverse outcomes.

**Discussion:** When fetal growth retardation is diagnosed during the third trimester of pregnancy, the obstetrician must decide whether the fetus is "constitutionally" small or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in resolving this question. The umbilical-placental and cerebral vascular beds are directly involved in the haemodynamic adjustments of fetal growth retardation.

A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and/or decreased cerebral resistance.

PI varies in relation to the intracranial artery considered, so it is important that the artery be identified precisely and with certainty.<sup>16</sup> In the evaluation of the fetal cerebral circulation, the MCA is the most accessible vessel and it can be easily located on colour doppler therefore the vessel of choice. It is the main branch of the circle of Willis and carries 80% of the blood flow to the ipsilateral cerebral hemisphere, a constant 3%–7% of cardiac output throughout gestation. Hence we used middle cerebral artery for the evaluation of fetal cerebral circulation.

We studied the Doppler index of umbilical artery only after 30th week, because in agreement with Schulman<sup>17</sup>, Gramellini<sup>11</sup> we believe that it is difficult to define normal

or abnormal umbilical flow velocity before 30th week, with the exception of absent end diastolic flow velocity after 20th week. Further more in most cases clinical issues concerning asymmetrical growth retardation (placental insufficiency) arise after the 30th week.

It is possible to use a single cut off value for cerebroplacental ratio after 30th week because cerebral - umbilical Doppler ratio does not vary significantly between 30th and 40th weeks as reported by Wladimiroff et al<sup>14</sup> who observed a significant differences in cerebroplacental ratio only between weeks 26 -38. After 26th week, the statistical comparison showed no significant differences between the intervals considered. Arbeille et al<sup>15</sup> also found the cerebral -placental ratio constant during the pregnancy and suggested 1 as the cut off value; all values below 1 were considered abnormal.

Several observational studies<sup>13,14,15</sup> have explored cerebral redistribution (abnormal MCA Doppler US result and/or abnormal MCA/UA Doppler ratio for the prediction of perinatal outcome in high -risk pregnancies .

We have studied about 50 pregnancies with clinical suspicion of IUGR. Mean birth weight at delivery was 2.43kg +/- 0.26 kg (2SD). 60% of neonates (n=30) had birth weight of less than 2.5 kg. 48% (n=24) fetuses had at least one adverse outcome; some (n=8 ) had more than one adverse outcome. Remaining 26 fetuses had favorable outcome. There were 7 intra uterine deaths and 43 live births. Of the 43 live births 8 Neonates were admitted to NICU. 7 neonates had 5 min Apgar score of less than 7 and 12 babies were born by emergency caesarian section.

By using the first Doppler US results for analysis, the MCA/UA pulsatility index ratio had a higher Sensitivity, Positive predictive value for adverse perinatal outcome than did the MCA pulsatility index and the UA PI. Our findings agree with the results of the studies that have shown MCA/UA PI Doppler ratio to be more useful than UA PI or MCA PI in predicting adverse outcome.

Doppler indices, in particular ratios that include measurements obtained from the umbilical and cerebral circulation, help in the recognition of the compromised growth-retarded fetus. In suspected IUGR, cerebroplacental Ratio (MCA/UA PI) is a better predictor of adverse perinatal outcome than an abnormal MCA PI or UAPI. Best results are obtained when we use MCA/UA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately.

Presence of Absent/Reversal of diastolic flow in Umbilical artery is an ominous sign since it carries a grave prognosis and high mortality. Fetal Doppler indices provide information that is not readily obtained from more conventional tests of fetal well being. Fetal Doppler velocimetry helps in the recognition of compromised growth retarded fetus thus allowing for timely interventions. It therefore has an important role to play in the management of the growth-retarded fetus.

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